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Geomorphological and isotopic characterization of soils in the proglacial area of Artesonraju Glacier (Cordillera Blanca, Peru)

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The Cordillera Blanca is the heaviest glacierized tropical mountain range in the world. Most of glaciers are retreating and shrinking leading to the formation of new soil and all types of glacial lakes at high altitude due to environmental modifications under climate change The glacierized catchment of Paron Lake is the largest deposit of melting ice in the Cordillera Blanca. The lake fills a U-shaped glacial valley and covers 1.6 km^2. This work aims to gain knowledge on the degree of soil and vegetation development on different parent materials and landforms in the Paron lake area at 4200 m a.s.l.. Soil properties might be characteristic of different materials and processes or reflect different ages of ice retreat. To this purpose a sampling scheme in the Paron Lake catchment was established obtaining a total of 70 soil samples to characterize the study area during a two weeks campaign in October 2016 supported by the IAEA INT /5/153 project. Furthermore, a multitemporal analysis of the Normalised Difference Vegetation Index of Landsat images was performed for the last decades in order to assess the vegetation dynamics.

To characterize the soils a total of 12 profiles were sampled until depths of 9 and 16 cm and then sectioned at 3 cm depth intervals. Furthermore, 40 surface soil samples (0-3 cm) on moraines, colluvium, alluvial terraces and alluvial fans were sampled. Main soil properties were measured, including soil organic carbon (SOC), total Carbon and Nitrogen, particle size distribution, pH, EC, carbonates, magnetic properties, stable elements and radionuclides (FRNs and ERNs). The soils are stony with a slightly acidic pH (mean: 5.9), low electric conductivity (mean: 0.06 dS m^{-1}) and loamy sand texture. The content of SOC ranged between 0.02 to 8.5 %. Fallout radionuclides (FRN's) ^{137}Cs and $^{210}Pb_{ex}$ reached values up to 1.8 and 165.8 Bq kg^{-1}, respectively, in the surface layers. The vertical distribution of SOC, EC and FRN's contents showed generally decreasing trends with depth. All topsoil samples contained $^{210}Pb_{ex}$ but apart from colluvium all the other materials contained ^{137}Cs.

Comparing the images used to calculate the NDVI, the increase in the value of the index in the last decades indicates an increase in the vegetation cover and density. Besides, we compare the NDVI with the distribution of soil nutrients to assess the impact of the vegetation increase in mountain soils.

These results outline the impact of the retreat of mountain glaciers on soils and vegetation cover. The characterization of soils and the analysis of the variations of NDVI allows to derive information on the degree of soil development and vegetation evolution that has been reached on the main landforms in this proglacial environment at the foot of Artesonraju Glacier along different glacial stages after LGM.